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ABSTRACT

The final revisions of 14 of the 15 strands for the Drill-and-practice Mathematics Program were completed. The numbers of lessons taken on the system was double that of the previous reporting period. Some changes were made in the way in which the Drill-and-practice Reading Program was handled. Additional adjustments were made in the curriculum, the operational assistance, the audio capacity, and the data retrieval system. Data was also compiled for the students using the reading program. Most of the work on the Logic and Algebra Program was concentrated on the second-year program. Developments in the Second-year Russian program included the completion of 113 lessons. A review of the goals and a progress report on the AID program for computer-assisted instruction (CAI) in computer programing is presented. Work continued on the SIMPER and LOGO programs for CAI in programing. The report provides tables of data concerning the use and effectiveness of the Institute's various programs, a discussion of the current developments in hardware and software, a list of lectures and publications presented by the staff, and a brief description of the activities planned for the next reporting period. (JY)

PROGRESS REPORT

STANFORD PROGRAM IN COMPUTER-ASSISTED INSTRUCTION

for the period

APRIL 1, 1969 to JUNE 30, 1969

Office of Education Contract OEC-0-8-001209-1806

National Aeronautics and Space Administration
Grant NGR-05-020-244

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Grant No. OEG-3-7-704721-5096
with McComb, Mississippi Public Schools

Stanford Subcontract under Office of Education
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with Ravenswood City School District

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INSTITUTE FOR MATHEMATICAL STUDIES IN THE SOCIAL SCIENCES
STANFORD UNIVERSITY
STANFORD, CALIFORNIA

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I. Major Activities of the Reporting Period

A. Drill-and-practice Mathematics Program

1. Strand Program

Final revisions for 14 of the 15 strands, grades 1 through 6, were completed. The problem-solving strand is still being revised. Since the algorithms for randomly generating problems for each equivalence class will not be thoroughly developed until after the beginning of the 1969 school year, the staff developed a temporary strand system. For this system problems for each equivalence class will be stored, and the student will receive problems sampled from the curriculum distribution. Further, the criterion for movement will be less complicated than for the final strand system.

2. Use of the System in Schools

The number of drill-and-practice lessons taken in elementary-school mathematics during this reporting period was 186,025, which is double the number reported for the previous quarter.

The number of teletype terminals on-line in early June, the peak period of the quarter, was 276. This number includes terminals used in the Russian language course. Figure 1 presents the configuration of the Stanford CAI system and includes the number of teletype terminals at each location.

The variation in the number of students run at each location during the months of May and June is due, in large part, to the different end-of-school dates. Schools in Kentucky and Mississippi closed late in May for the year, while California schools closed at the end of the second and third weeks in June.

Table 1 shows the number of lessons taken in each school for each day of each month of the reporting period. Both the number of lessons taken each day at all schools and the number of lessons taken each month at each school are included.

Table 2 presents the total number of lessons taken each month at schools in each geographic area, together with monthly totals for each area.

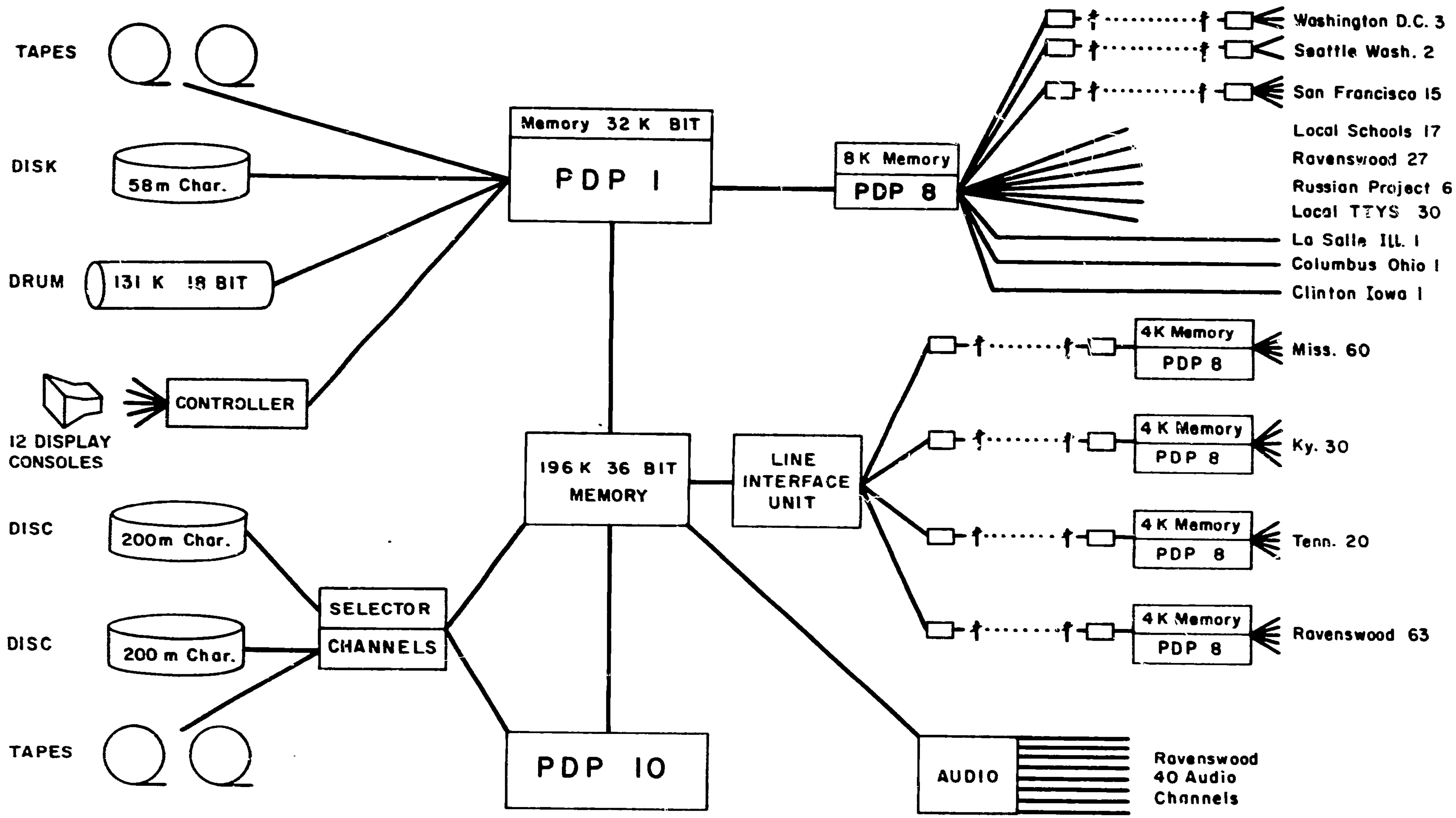

Fig. 1. The Stanford CAI configuration and the number of teletype terminals at each location, June, 1969, mathematics program.

TABLE 1

MONTHLY DISTRIBUTION OF DRILLS RUN PER SCHOOL
APRIL, 1969

	1	2	3	4	7	8	9	10	14	15	16	17	18	21	22	23	24	25	28	29	30	RUNS PER SCHOOL
CALIF.																						
0	120	113	*	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	293
1	*	*	*	*	152	160	119	24	131	159	116	125	168	113	199	159	107	124	0	133	119	2107
2	*	*	*	*	46	44	37	8	39	36	39	5	40	29	15	36	23	25	0	31	37	499
3	*	*	*	*	99	94	101	11	129	93	106	97	109	114	207	139	152	101	0	118	144	1914
4	*	*	*	*	26	0	31	0	20	0	19	0	0	20	0	28	0	0	0	0	0	144
5	*	*	*	*	58	54	46	18	61	62	67	47	70	35	65	34	29	29	9	22	90	796
6	5	4	3	4	5	4	4	1	3	37	33	23	0	3	3	5	1	0	15	1	2	156
16			3	1	3	9	6	6	12	5	10	9	10	8	66	16	7	5	0	6	12	[illegible]
BRENTWOOD																						
100	*	*	*	*	207	219	*	105	195	196	200	177	168	168	185	134	176	133	0	159	139	2559
101	*	*	*	*	428	423	*	212	322	366	342	370	374	393	494	422	125	39	100	489	470	5369
102	*	*	*	*	186	235	1	38	155	191	155	180	207	155	201	137	31	0	66	227	236	2401
103	*	*	*	*	206	260	*	82	159	135	147	156	94	186	171	197	151	44	0	147	201	2336
104	*	*	*	*	212	172	*	78	140	124	145	152	123	187	181	229	57	13	45	183	200	2241
105	*	*	*	*	124	135	*	0	86	141	137	107	78	143	146	121	6	13	48	135	126	1546
106	*	*	*	*	216	180	*	142	216	135	165	129	199	173	277	166	38	17	1	194	205	2453
107	*	*	*	*	133	130	*	50	138	140	157	120	122	104	137	122	123	70	0	118	164	1829
108			6	0	7	50	1	43	38	56	48	126	45	18	40	372	26	8	11	40	34	969
WASHINGTON																						
10	143	132	52	0	3	53	15	1	125	95	133	125	79	84	119	105	59	60	0	70	96	1549
OHIO																						
11	22	20	19	*	*	16	7	11	18	22	8	12	25	16	33	29	27	32	0	30	37	384
12	33	28	35	*	*	6	3	0	7	22	27	19	27	20	5	25	15	20	0	8	38	338
13	*	*	*	*	68	25	14	11	37	0	17	17	11	28	6	41	38	0	0	36	44	393
19			2	0	0	3	6	0	4	1	0	3	0	1	0	0	0	2	0	26	0	48
IOWA																						
14	9	8	8	1	13	8	7	6	7	6	5	11	3	8	10	6	3	3	0	3	3	128
18								1	0	0	0	0	0	0	0	0	0	0	12	14	5	30
TENNESSEE																						
80	98	143	87	59	165	107	81	60	96	111	114	95	120	33	63	71	52	64	2	37	48	1736
81			24	31	75	227	21	3	3	0	14	2	18	2	6	9	3	8	0	1	2	449
MISSISSIPPI																						
20	206	141	101	75	135	154	145	54.	162	71	121	133	41	161	239	201	112	161	0	210	253	2876
21	305	177	281	161	327	345	294	86	359	203	370	336	1	196	252	361	213	319	0	382	404	5372
22	12	30	30	16	33	32	24	7	25	25	30	29	1	22	24	20	14	17	0	24	23	458
23	184	121	108	64	101	145	95	26	141	56	67	173	1	153	198	141	69	117	0	143	176	2269
24	169	112	122	83	114	132	69	47	128	72	142	140	28	119	127	138	80	147	0	152	168	2289
25	180	140	96	77	123	147	110	33	108	108	187	210	47	156	216	158	108	152	0	181	237	2774
26	194	102	111	79	146	154	114	39	137	110	125	171	44	110	97	182	79	177	0	185	195	2551
27	338	235	244	169	279	288	285	80	305	132	319	144	47	260	345	307	126	302	0	258	303	4766
28	70	5	10	6	7	10	21	2	8	12	13	0	1	19	23	20	9	29	0	53	42	359
29	42	16	0	0	6	7	8	0	11	0	4	29	1	35	14	31	15	29	0	35	63	346
30	21	5	0	0	14	8	2	5	11	14	24	26	0	0	0	0	0	0	0	32	21	183
31	46	34	28	15	0	0	0	5	36	9	33	30	0	40	37	25	16	24	0	21	24	423
32	0	0	0	6	0	1	20	1	11	10	0	58	0	0	0	0	0	12	0	0	16	135
33	43	18	0	0	29	15	25	9	8	4	10	24	1	19	15	21	7	14	0	13	31	306
34	8	8	10	0	0	1	23	7	0	0	5	0	0	0	0	1	5	0	0	0	0	69
35			1	0	4	2	3	3	8	32	5	13	8	27	13	0	23	1	0	3	0	158
KENTUCKY																						
40	12	20	20	13	*	3	*	*	49	56	83	87	60	57	112	59	42	68	0	71	72	884
41	95	71	11	0	*	*	*	*	41	32	69	62	53	65	92	74	40	19	15	84	77	900
42	0	0	0	8	*	*	*	*	22	21	43	38	53	42	8	48	31	1	0	21	22	358
43	53	44	23	4	*	*	*	*	21	26	22	11	0	25	38	50	35	68	0	53	74	549
44	0	0	0	12	*	*	*	*	13	10	14	28	29	22	26	28	29	31	0	10	16	268
45	42	52	49	16	52	54	*	*	0	9	19	92	67	52	63	59	31	58	0	47	47	769
46	33	29	32	25	*	*	*	*	41	18	53	55	60	40	70	52	42	72	0	46	49	717
47	26	2	34	0	31	32	*	9	27	0	39	38	36	26	30	40	26	48	0	38	41	503
48	55	35	33	0	*	*	3	0	28	21	51	20	20	41	45	50	50	69	0	57	79	657
49	56	48	59	30	*	*	*	*	66	31	59	74	59	64	49	65	27	70	0	65	62	984
50	62	71	54	0	*	*	*	*	2	6	64	92	79	56	80	66	54	37	0	7	37	767
51	31	20	8	0	*	*	*	*	9	13	6	3	18	25	18	17	13	4	0	8	17	210
52	14	9	2	0	*	*	*	*	0	0	0	0	2	2	1	0	19	14	0	18	11	[illegible]
53	37	43	25	0	*	*	*	*	46	15	34	38	36	27	23	15	1	39	0	13	14	406
54	29	29	28	15	45	43	0	*	43	15	59	64	65	63	56	32	25	35	0	52	57	755
55	84	66	26	0	*	*	*	*	63	23	62	41	50	50	68	54	47	68	0	50	40	900
56	20	22	21	0	*	*	*	*	22	6	26	35	25	20	3	0	8	22	0	1	11	242
57	26	25	26	18	*	*	*	*	25	23	33	33	33	39	26	57	29	52	0	53	51	547
58	33	24	0	18	38	42	3	22	11	1	29	25	30	11	25	14	15	16	0	21	7	385
59	4	2	2	5	*	*	*	*	0	0	10	38	43	21	32	23	19	30	0	37	55	300
60	0	10	23	16	*	*	*	*	18	4	20	21	14	12	23	23	29	36	0	21	26	296
61	90	62	51	43	*	*	*	*	44	72	78	74	78	72	92	71	72	74	0	76	72	1101
62	34	1	27	0	63	28	6	3	20	16	6	31	25	22	25	30	35	61	0	12	10	455
63	66	36	30	0	72	55	14	0	52	17	50	57	28	44	48	27	24	39	14	49	33	755
64	18	18	52	33	*	*	*	*	48	35	55	63	58	71	58	51	57	55	0	55	60	787
65	1	0	0	0	*	*	*	*	30	3	7	16	33	45	50	46	46	49	0	46	51	423
66	23	17	10	16	19	24	1	*	36	24	49	42	22	15	41	17	0	0	0	42	41	439
67	71	63	0	38	*	*	*	*	71	35	57	37	52	44	14	4	1	52	0	0	0	539
68	0	0	0	0	0	*	*	*	0	0	0	0	4	13	14	34	23	23	0	30	22	163
69									12	3	0	2	48	47	49	46	43	46	0	40	49	393
70			61	38	2	14	9	8	35	46	33	62	90	55	35	14	47	8	0	63	24	650
TOT.	3313	2411	2090	1195	4072	4350	1774	1357	4493	3572	4789	4962	3581	4546	5521	5378	3084	3574	344	5149	5023	75079

* SCHOOL HOLIDAY

NOTES:

1. APRIL 11 - NO ENTRY SHOWN, AS FINAL SUMMARY AND DISTRIBUTION WAS LOST. HOWEVER THERE WAS SOME 2655 RUNS AS OF 2 P.M.
2. APRIL 25 - ONLY PART OF THE DAY'S RUN SHOWN, AS FINAL SUMMARY AND DISTRIBUTION WERE LOST AGAIN. AS OF 5:30 P.M. THERE WERE 4655 RUNS RECORDED.
3. APRIL 28TH - PDP-10 WAS DOWN UNTIL 2 P.M. DUE TO DISK TROUBLES.
4. APRIL 30TH - IOWA'S LAST DAY RUNNING, DUE TO CLOSE OUT OF JOB CORPS CENTER.

TABLE 1 (cont.)

MONTHLY DISTRIBUTION OF DRILLS RUN PER SCHOOL
MAY, 1969

	1	2	5	6	7	8	9	12	13	14	15	16	19	20	21	22	23	26	27	28	29	30*	RUNS PER SCHOOL
CALIF.																							
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	440	0	0	0	440
1	25	92	122	122	90	133	89	89	41	19	123	93	115	38	62	127	64	29	0	135	69	0	1677
2	28	39	38	52	0	0	70	37	28	47	74	32	67	77	51	52	47	48	0	15	31	0	833
3	93	131	85	124	88	102	107	87	25	40	86	111	146	127	93	124	109	111	0	107	110	0	2006
4	0	0	34	0	29	0	0	27	0	32	0	0	29	0	28	1	0	14	0	0	0	0	194
5	22	46	19	23	65	27	47	30	44	35	48	51	47	58	33	47	35	44	0	61	52	0	834
6	0	0	0	1	12	1	13	3	5	5	4	2	1	8	4	2	0	0	4	5	0	0	70
16	9	1	6	21	1	7	12	4	3	6	10	2	5	0	19	2	17	0	0	0	2	0	127
BRENTWOOD																							
100	42	1136	1089	1847	1899	1721	1907	1417	1167	177	222	202	185	251	254	246	186	160	2157	280	159	0	16704
101	426	0	0	0	0	0	0	0	0	489	678	672	497	771	805	710	716	429	0	767	797	0	7757
102	150	166	184	0	0	0	0	0	0	175	247	201	160	219	234	188	252	100	0	241	253	0	2770
103	74	0	0	0	0	0	0	0	0	187	190	164	89	146	170	191	140	175	0	91	81	0	1698
104	171	0	0	0	0	0	0	0	0	185	204	193	151	169	255	236	239	125	0	218	243	0	2389
105	113	0	0	0	0	140	0	0	0	103	109	137	104	143	119	132	132	65	0	115	152	0	1564
106	3	76	68	0	0	0	0	1	2	92	181	181	87	115	139	190	234	64	0	201	108	0	1742
107	111	0	0	0	0	0	0	0	17	140	181	190	118	187	19	168	175	132	0	177	175	0	1790
108	37	0	0	0	0	0	0	0	0	95	118	70	40	74	92	83	67	35	0	80	47	0	838
WASHINGTON																							
10	56	57	57	71	83	73	74	88	55	80	84	61	81	55	90	59	84	57	70	75	77	0	1497
17	3	0	4	5	2	7	5	7	2	4	8	0	2	0	4	0	0	0	0	2	7	0	62
OHIO																							
11	12	15	29	31	0	31	31	28	23	27	29	22	8	30	39	38	34	15	81	18	5	0	546
12	21	23	12	28	0	13	28	13	9	16	31	16	19	30	31	27	32	14	0	32	6	0	401
13	33	28	14	37	0	0	27	24	28	11	41	42	38	39	52	45	48	53	0	45	0	0	605
19	0	2	1	1	1	3	0	0	0	0	0	1	1	1	0	0	1	1	0	1	0	0	14
TENNESSEE																							
80	46	58	61	67	73	56	58	40	48	45	62	49	54	60	70	58	103	66	73	44	73	108	1372
81	0	4	0	3	12	11	0	5	0	7	0	1	3	0	8	8	18	0	0	0	34	34	148
MISSISSIPPI																							
20	182	133	201	158	112	168	186	200	159	152	196	216	156	245	251	246	166	151	846	43	4	0	4171
21	363	361	352	290	279	373	346	391	350	364	462	265	361	413	411	449	400	289	0	1	1	0	6521
22	27	15	21	21	16	23	26	28	26	33	18	14	23	1	20	21	28	27	0	11	0	0	399
23	151	130	84	95	89	111	153	132	92	188	187	183	105	145	174	143	178	97	0	0	0	0	2437
24	147	171	160	112	117	171	191	179	183	189	229	228	166	184	174	189	184	166	0	0	0	0	3140
25	186	186	179	133	94	143	215	179	158	169	188	205	154	193	208	199	181	141	0	0	0	0	3111
26	177	185	89	101	65	146	148	121	116	133	175	146	88	100	157	111	193	151	0	0	0	0	2402
27	280	303	265	279	245	298	299	215	237	372	395	356	266	337	400	388	186	287	0	4	1	0	5413
28	31	44	44	41	0	0	1	41	43	53	58	6	0	32	28	21	11	3	0	0	0	0	457
29	36	56	41	41	18	38	51	56	49	57	57	58	31	57	51	55	55	0	0	0	0	0	807
30	3	6	4	20	21	31	20	7	15	8	31	32	23	30	31	31	32	19	0	0	0	0	364
31	28	25	35	26	21	26	31	29	23	24	23	28	25	29	48	45	37	0	0	27	3	0	533
32	42	0	50	36	34	51	10	7	0	18	14	9	0	2	3	2	0	0	0	0	0	0	278
33	18	0	18	11	0	10	52	29	31	50	51	57	15	23	39	69	3	0	0	0	0	0	496
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	7	5	15	13	17	8	14	7	8	12	29	94	19	26	44	47	32	35	0	4	1	0	437
KENTUCKY																							
40	73	77	53	26	46	45	73	45	66	64	74	77	58	85	63	75	58	29	0	0	0	0	1087
41	62	52	23	45	14	43	94	79	64	69	6	0	1	36	47	0	11	8	0	0	0	0	654
42	23	0	0	27	40	47	41	41	32	45	44	36	36	41	45	39	39	3	0	0	0	0	579
43	65	59	58	63	68	70	74	64	60	73	71	75	69	74	60	47	17	0	0	0	0	0	1067
44	5	4	1	12	12	2	0	1	0	28	16	20	12	4	15	15	10	0	0	0	0	0	157
45	60	42	27	60	54	60	58	49	40	52	57	59	62	38	58	55	51	0	0	0	0	0	882
46	30	46	43	30	47	50	50	34	34	35	23	32	0	0	0	0	0	0	0	0	0	0	454
47	18	38	33	30	43	56	42	28	22	30	33	24	30	33	28	45	29	1	0	0	0	0	563
48	75	73	48	58	0	0	38	50	26	40	21	0	23	30	0	42	0	0	0	0	0	0	524
49	68	63	62	67	63	39	52	32	27	41	51	62	67	60	53	0	1	0	0	0	0	0	808
50	41	41	66	45	36	56	38	42	30	46	64	46	38	40	41	48	42	0	0	0	0	0	760
51	14	15	12	15	33	13	0	0	0	0	0	6	19	17	0	1	0	0	0	0	0	0	145
52	25	21	16	29	6	7	30	15	7	10	0	0	0	0	0	0	0	0	0	0	0	0	166
53	33	24	29	27	20	34	36	22	12	24	37	22	23	25	31	21	27	0	0	0	0	0	447
54	31	41	41	12	48	57	54	37	2	0	27	17	50	44	0	53	41	0	0	0	0	0	555
55	46	47	35	46	53	56	46	53	34	67	65	52	54	60	58	65	51	1	0	0	0	0	889
56	10	15	20	18	14	24	21	27	2	22	25	16	20	13	25	18	15	0	0	0	0	0	305
57	53	50	52	54	50	51	54	51	44	55	57	53	52	54	55	53	55	3	0	0	0	0	896
58	0	0	14	11	15	10	22	15	10	10	1	1	0	0	0	0	0	0	0	0	0	0	109
59	16	38	35	30	29	31	28	14	12	18	30	23	21	33	6	20	0	0	0	0	0	0	384
60	18	19	13	20	18	21	11	19	12	21	9	8	9	0	0	0	0	0	0	0	0	0	198
61	77	74	55	62	65	82	8	0	50	79	61	67	76	81	78	96	84	1	0	0	0	0	1096
62	8	0	32	0	0	36	51	0	26	34	0	1	0	0	0	0	0	0	0	0	0	0	188
63	22	23	30	34	26	33	41	2	6	35	30	32	8	1	0	0	0	0	0	0	0	0	323
64	36	54	53	42	39	53	56	24	44	62	58	43	0	0	0	0	0	0	0	0	0	0	564
65	48	48	47	45	48	44	34	16	35	42	52	50	42	47	45	46	70	0	0	0	0	0	759
66	45	42	27	20	32	36	26	25	17	44	31	46	29	40	47	41	41	0	0	0	0	0	589
67	21	28	39	46	39	25	0	0	0	0	0	0	18	30	63	54	52	0	0	0	0	0	415
68	13	33	37	21	27	23	0	11	25	28	23	24	30	27	26	30	23	0	0	0	0	0	401
69	46	47	39	33	9	4	0	0	4	48	49	0	33	19	36	3	0	0	0	0	0	0	370
70	11	10	11	17	10	43	23	43	19	53	45	41	38	36	45	26	28	1	0	0	0	0	500
TOT.	4246	4618	4432	4855	4487	5073	5312	4360	3749	5014	5903	5323	4397	5393	5655	5643	5164	3150	3671	2500	2491	142	95878

* SCHOOL HOLIDAY

NOTES:

TABLE 1 (cont.)

MONTHLY DISTRIBUTION OF DRILLS RUN PER SCHOOL
JUNE, 1969

	2	3	4	5	6	9	10	11		20	23	24	25	26	27	30	TOTAL
CALIF.																	
0	0	0	0	0	0	0	0	0									0
1	26	72	53	87	84	0	0	0	S								322
2	14	42	37	57	32	8	51	0	U								241
3	65	43	32	126	27	82	88	0	M								463
4	0	0	0	0	0	0	0	0	M								0
5	13	25	35	63	0	15	42	9	E								202
6	2	5	0	3	3	3	4	0	R		10	17	21	3	0	0	71
16	3	1	2	4	20	19	24	22		18	19	0	22	5	65	16	240
BRENTWOOD																	
100	78	168	112	224	193	209	264	178	S	0	0	22	54	114	39	98	1753
101	196	570	424	641	378	458	644	836	C	0	0	0	93	0	106	227	4573
102	57	158	150	191	232	190	250	267	H								1495
103	48	159	37	0	173	195	200	160	O								972
104	60	170	173	159	152	145	221	232	O	0	0	0	14	0	30	50	1406
105	56	90	87	116	124	110	0	139	L								722
106	26	25	0	65	2	116	129	96									459
107	53	160	141	162	93	164	200	188		0	0	26	57	0	69	0	1313
108	5	14	13	27	24	25	25	7									140
WASHINGTON																	
10	47	40	64	64	48	37	7	1									308
17	2	1	0	0	0	0	1	3									7
TENNESSEE																	
80	1	0	0	0	0	0	1	0		0	0	0	14	0	25	35	76
81	4	0	0	0	0	0	0	1		0	0	4	0	0	0	40	49
SEATTLE																	
2							5	1		5	7	24	17	15	15	28	117
1										5	20	27	31	15	30	39	167
	756	1743	1360	1989	1585	1776	2156	2140		28	56	120	323	152	379	533	15096

TABLE 2

Monthly Distribution of Mathematics Drills Run Per Area

	California	Iowa	Kentucky	Mississippi	Ohio	Ravenswood	Seattle	Tennessee	Washington	Total
April										
1	185	9	1,005	1,818	55	0		98	143	3,313
2	117	8	819	1,144	48	0		143	132	2,411
3	6	8	709	1,142	56	6		111	52	2,090
4	5	1	348	751	0	0		90	0	1,195
7	389	13	322	1,318	68	1,719		240	3	4,072
8	365	8	295	1,441	50	1,804		334	53	4,350
9	344	7	36	1,238	30	2		102	15	1,774
10	68	7	42	404	22	750		63	1	1,357
14	394	7	895	1,458	66	1,449		99	125	4,493
15	392	6	581	858	45	1,484		111	95	3,572
16	390	5	1,130	1,455	52	1,496		128	133	4,789
17	306	11	1,239	1,516	51	1,517		97	125	4,862
18	397	3	1,270	221	63	1,410		138	79	3,581
21	322	8	1,188	1,317	65	1,527		35	84	4,546
22	555	10	1,304	1,590	44	1,830		69	119	5,521
23	416	6	1,164	1,612	95	1,900		80	105	5,378
24	319	3	959	876	80	733		55	59	3,084
25	284	3	1,264	1,500	54	337		72	60	3,574
28	24	12	35	0	0	271		2	0	344
29	311	17	1,200	1,692	100	1,691		68	70	5,149
30	404	8	1,209	1,962	119	1,775		50	96	5,623
Total	5,993	160	17,014	25,313	1,163	21,701		2,185	1,549	75,078

April 11 - No entry, data lost.
April 25 - Only partial data shown.
April 28 - System down until 1:50 p.m..

	California	Iowa	Kentucky	Mississippi	Ohio	Ravenswood	Seattle	Tennessee	Washington	Total
May										
1	177		1,093	1,678	66	1,127		46	59	4,246
2	309		1,124	1,620	68	1,378		62	57	4,618
5	304		1,051	1,558	56	1,341		61	61	4,432
6	343		1,045	1,377	97	1,847		70	76	4,855
7	285		1,004	1,128	1	1,899		85	85	4,487
8	270		1,151	1,597	47	1,861		67	80	5,073
9	338		1,101	1,743	86	1,907		58	79	5,312
12	277		839	1,621	65	1,418		45	95	4,360
13	146		762	1,490	60	1,186		48	57	3,749
14	184		1,175	1,822	54	1,643		52	84	5,014
15	345		1,060	2,113	101	2,130		62	92	5,903
16	291		933	1,897	81	2,010		50	61	5,323
19	410		918	1,432	66	1,431		57	83	4,397
20	308		968	1,817	100	2,075		60	65	5,393
21	290		925	2,059	122	2,087		78	94	5,655
22	355		893	2,016	110	2,144		66	59	5,643
23	272		745	1,686	115	2,141		121	84	5,164
26	246		47	1,366	83	1,285		66	57	3,150
27	444		0	846	81	2,157		73	70	3,671
28	323		0	90	96	2,170		44	77	2,800
29	264		0	10	11	2,015		107	84	2,491
30	0		0	0	0	0		142	0	142
Total	6,181		16,834	30,966	1,566	37,252		1,520	1,559	95,878
June										
2	123					579		5	49	756
3	188					1,514		0	41	1,743
4	159					1,137		0	64	1,360
5	340					1,585		0	64	1,989
6	166					1,371		0	48	1,585
9	127					1,612		0	37	1,776
10	209					1,933	5	1	8	2,156
11	31					2,103	1	1	4	2,140
				SUMMER SCHOOL 1969						
20	18					0	10	0	0	28
23	29					0	27	0	0	56
24	17					48	51	4	0	120
25	43					218	48	14	0	323
26	8					114	30	0	0	152
27	65					244	45	25	0	379
30	16					375	67	75	0	533
Total	1,539					12,833	284	125	315	15,096

Teacher reports. The number of on-line reports available to teachers was increased during this reporting period. A sample call-up procedure and report as given in CAI Newsletter No. 3, May, 1969, follows:

New Procedures

Daily reports.

For those of you who have not already heard, it is now possible for you to request your daily report at any time. In fact, you must request your daily report in order to receive it. It will no longer be sent automatically each day.

The request procedure is simple:

1. When the machine says "Please type your number and name," type 0 REPORT (zero report).
2. The machine will then type class CLASS from FROM which means which class number do you wish to begin with for the report. Type class number and return.
3. The machine will then type TO which means which class do you want to end with on the report. Type class number and return. If you have only one class, put that number in both places, after the "FROM" and again after the "TO." If you have classes 45, 46, and 47, and you type FROM 45 TO 47, you will get all three reports. A sample report request together with a report is shown in Figure 1.
4. To return to regular lessons, type CONTROL S.
5. To stop any report, finished or not, type CONTROL C. Then push the start button.

```
PLEASE TYPE YOUR NUMBER AND NAME.
0 REPORT
CLASS
FROM 28
TO 28

..........

CLASS
FROM 31
TO 31

..........

CLASS  31           15 MAY 1969
21 STUDENTS

MISS. JAN MURPHY          3 OAK KNOLL

STUDENTS THAT HAVE NOT RUN TODAY

  426 MISS. JAN MURPHY           A( 90)  A301000( 90)
  443 DANA CASSLEY               B( 40)  L310044( 64)  4( 76)
  453 ERIC MANSFIELD             B( 65)  L309035(100)  4( 82)
  412 BARBARA FLUCKIGER          A( 60)  B310064( 65)  4( 76)
  413 DAVID HAIGHT               B( 60)  L310044( 93)  3( 83)
  415 ROBERT HARRIS              B( 81)  L210034( 56)  4( 82)
  422 ERIC MILLER                A( 88)  L207055(100)  5( 90)
  430 JACK MOZLEY                A( 80)  L309014( 79)  5( 82)
  457 RICH SINNOTT               B( 95)  L312045( 86)  4( 76)
  424 LAURA SPIVACK              A( 70)  L301033(100)  5( 79)

STUDENTS BELOW 20 PCT. OF THEIR AVERAGE

  440 WILLIE BIAGI               A( 50)  L311033( 57)  5( 78)
  460 SCOTT TETER                A( 25)  L303052( 21)  3( 65)

STUDENTS ABOO PCT. OF THEIR AVERAGE

  438 ALLAN BEDWELL              A( 55)  L310013(100)  4( 77)
  461 ALLISON TITLEY             B( 60)  L310052(100)  3( 73)

STUDENTS WITHIN 20 PCT. OF THEIR AVERAGE

  436 BRUCE BAER                 A( 65)  B301065(100)  4( 84)
  441 HEIDI BLACKBURN            B(100)  B312005(100)  3( 81)
  444 DICK CLARK                 A( 75)  L301043( 86)  3( 78)
  456 PHILIP SCHNEIDER           A( 50)  A310004( 50)  3( 70)
  445 ROBIN DAVIDSON             B( 60)  L301054( 71)  4( 77)

NUMBER OF STUDENTS PER CONCEPT
 301 302 207 210 303 309 310 311 312
   4   1   1   1   1   2   5   2   2

...........
```

Fig. 1. Sample report request and report.

3. California Schools

A total of 13,713 lessons were given on 17 local teletype terminals and 71,876 lessons were given on 50 teletype terminals located in the Ravenswood City School District. The number of lessons taken in the Ravenswood schools increased significantly. Though all the system problems had not been solved during this period, the efficient organization and operation of the system by the Ravenswood project staff were responsible for the increase in lessons.

The results to date of achievement gain and attitude improvement by students in Peter Burnett Junior High School in San Jose, California were most encouraging. IMSSS CAI Newsletter No. 2 (attached to this report) i.~ludes an account of the results. The account was written by the vice principal of the school, Mr. James Moriel.

4. Kentucky Schools

More than 33,848 lessons were given to Kentucky students during the period as shown in Tables 1 and 2. The difficulties encountered in the earlier quarter were largely resolved. The consistent daily-run figures in Table 1 attest to the use to which teachers put the system, particularly during the month of May. The last full day of operation for Kentucky schools was May 23. They will not run during summer session this year.

5. Mississippi Schools

The Mississippi school children took more than 56,279 arithmetic lessons on their 60 teletypes this quarter. The grade-placement gain and retention of material presented for these children have been significant each year.

6. Ohio Schools

Three teletypes, connected in tandem and thus appearing as one user, were installed last quarter. Students in the three schools involved took more than 2,729 arithmetic lessons during the quarter. The first machine ran until noon each day. Then the second machine in another school was switched on and ran from noon until 3:30 p.m. each day. The third teletype was manned by parents in still another school during the afternoon hours. In all, the operation was most efficient in terms of the number of students run each day.

The results from one school, Chapelfield Elementary, were reported. Pretest-posttest scores from the computational section of the Iowa Test of Educational Development were used with the sixth-grade class involved.

Achievement test scores indicated a 2.2 month mean gain per calendar month during the eight-month period covered by the test. In all, the 28 students in the teletype class scored a one-year and seven-month grade-placement advance in eight months. We regret that they did not establish control groups. The results, however, are still encouraging.

7. Tennessee A. and I State University

Freshman students in remedial mathematics classes completed more than 3,803 review lessons of arithmetic fundamentals and introduction to algebra.

8. Washington, D.C.

There were more than 3,423 lessons given on the three teletype terminals located at Kendall School for the Deaf this quarter. To date, the system has worked reliably, and students and staff remain enthusiastic.

9. Other Schools

Two teletype terminals were installed in Seattle, Washington--one in the University of Washington's Experimental Education Unit, the other in a nearby school for the handicapped. This installation was for the summer session only to explore the potential value of this type of instruction with children of various types of handicaps.

The Job Corps Center at Clinton, Iowa was discontinued during the quarter, consequently, our operation there was terminated.

The teletype in the home of Mr. Peter Miller of LaSalle, Illinois is still used and enthusiastically supported by Mr. Miller. He schedules local school children, in addition to his own, for daily lessons in order to generate interest for the program in the local schools.

B. Drill-and-practice Reading Program

The CAI Reading Program ran through the end of the 1969 school year and was continued, after a two-weeks' pause, in the Ravenswood City School District summer school program. Based on observations of the students, four notable changes were made in the reading program. First, a readiness strand was added to acquaint new students with the program, to identify students who might have difficulty interacting with teletypes, and specifically, to teach students to sign themselves onto the reading program. All students using the program for the first time now complete the readiness strand before beginning the mainline curriculum.

Most students complete this readiness strand in their first session. Second, students who accumulate less than 20 minutes in the reading program are given an audio reminder to type the space bar if they forget to enter an otherwise correct response. Third, initial entry into the four strands is staggered. Each student completes three sections of the letter strand before beginning the word strand, five sections of the word strand before beginning the phonics strand, and three sections of the phonics strand before beginning the spelling strand. Once begun, a student's progress in a strand is independent of his progress in the other strands. Fourth, students are not permitted entry into a higher numbered section in the spelling strand than the one they achieved in the phonics strand.

The standard IMSSS keytops and typewheels will be used indefinitely instead of switching to the keytops and typewheels with both upper- and lower-case letters, because they proved to be less legible for the students.

1. The Revised Readiness Strand

To sign on the reading program, a student types R followed by his number, a space, his first name, and another space. The program then responds with the student's last name. If his last name is correct, the student types a space and the program proceeds with his lesson. The readiness strand teaches students to sign themselves on independent of proctor supervision. The format of each readiness response request is the following: the program plays TYPE followed by the name of the character and waits 15 seconds for the student's response. If the response is correct, the program plays GOOD randomly with probability of .50, types the correct character and continues. If the student's response is incorrect, the program plays NO, YOU TYPED followed by the name of the character the student typed, WE WANTED followed by the name of the correct character; it then types the correct character followed by a return, two line feeds, all the characters the student has entered correctly up to his last incorrect response, and repeats the response request. If a student delays his response beyond the allotted time, the program plays TOO MUCH TIME and begins the wrong-answer sequence beginning with the WE WANTED message. This format is used as the student types R for reading, his number, a space, and his first name as he is required to do in signing himself on. To leave the readiness strand a student must perform the sign-on sequence with no more than one error. The readiness strand differs from all other reading strands in that branching from it is criterion dependent rather than time dependent.

2. Curriculum, Additions, and Adjustments

Three-quarters of the planned curriculum has been entered for preprocessing. The proposed written material for the fifth strand, word meaning, was completed using words from the sight-word strand vocabulary of the first three basal readers. In the two exercises of the word-meaning strand, the student chooses the one word from a group of three that matches an audio presented category and then chooses one word from a choice of three and types it to complete a sentence.

The inputting and preprocessing of the word-meaning strand curriculum were postponed during this period in lieu of (a) making corrections and substitutions in the existing program, and (b) exploring and using opportunities for greater variety within the exercises.

As the availability of the dictionary increased with more flexible utility programs and the vocabulary was enlarged with the addition of the second- and third-grade words, richer word types became available for exemplars in the phonics and spelling strands. The program allows the input and preprocessing of new material over the old, and thus substitutions were made as well as exchanges of some section items to provide maximum discrimination among certain sounds. Daily improvements were made in audio quality; however, certain fricatives, plosives, and sibilants in our language retain their sound confusion over a telephone system.

3. Operational Assistance

As the reading program became operative on a class-scheduled basis, the project staff members made frequent trips to the schools to observe and to answer questions. A workshop was held to familiarize the proctors with those aspects unique to the reading program. In addition to the <u>Reading Manual</u>, the <u>Curriculum Guide</u> and its use were discussed as a measure of student placement or progress and its relation to the student's classroom text. At this time, procedures for collecting and interpreting teacher reports were explained and practiced. Effective means of dispersion of this information to the classroom teacher were discussed.

Each proctor was given a log book in which to enter her anecdotal comments (or those of the students), suggestions, or particular problems. These logs have proved valuable when reviewed by visiting staff members and district personnel in evaluating quality adjustments in the audio, length of lessons, student reactions, and curriculum difficulties.

4. Audio Development

Audio capacity increased from 1,000 words, or approximately 20 per cent of the total curriculum vocabulary, to 35,000 words, which equals 70 per cent of the total word goal. A male voice, found to be better suited to the optimum frequency ranges, was used to record the words on-line without prior taping. The equipment used was a microphone on a Philco Console housed in the Stanford Computer Laboratory.

The quality of the audio significantly improved by doubling the sampling rate from one bit 36,000 times per second to one bit 72,000 times per second. This change in rate cut in half the maximum message length. Noise remains in the recording signal and certain sounds continue to be ambiguous, i.e., "pin" is easily confused with "tin."

The major task in audio development is now largely a matter of editing, i.e., eliminating pauses and noise before and after each word.

Supporting programs for audio include a speech editor with a variety of options that allows ready access to any audio message by its numerical identifier. Automatic record mode permits consecutive input and immediate playback, both to reduce recording time and to keep pitch and volume levels constant. Other programs create an audio directory from the original curriculum, numbering, alphabetical sorting, and conversion of the directory to binary form for preprocessing the curriculum.

Attempts at sentence building by concatenating words indicate the need for closer analysis of intonational factors in recording. In its present form the audio sacrifices interchangeableness for naturalness.

5. Data Retrieval

An on-line utility program, O RPORTS, was written to provide the following:

1. The retrieval of individual student information. Given a student number, this routine prints the student's name, class, grade, and school number, the section number and the specific items he is working on in each of the four strands, together with the total minutes he has accumulated in the reading program. An example of this report appears in Figure 2.

```
                 INDIVIDUAL STUDENT

STUDENT NO: 1578

1578     DEBBIE NAKAMURA    C: 82    G: 4    S: 7

L-18   B   R  P

W-15  SPIN   STOP   TOP

PH-7  -EM   -EP   -EG

SP-3  LAND   SAND   HAND

ACC. MIN.: 73.6
```

Fig. 2. On-line utility program for the individual student, reading program.

2. The retrieval of class information. Given a class number, this routine prints the date, total number of students in the class, name of the teacher, and, for each student who has signed on the reading at least once, the number of minutes accumulated in the reading program, the section number of the curriculum items he is involved with in each strand, his identification number, an indication of whether he ran on the day of the report, and his name. Students not flagged for reading are not listed in the report. Conversely, students who are flagged for reading but who have not signed on to reading are listed, but no information is given for them. Within class averages, minimums and maximums for accumulated minutes and the four section numbers are printed at the end of the report as summary statistics. An example of this report appears in Figure 3. A faster listing is provided by omitting student numbers and names as shown in Figure 4, or omitting all but the summary statistics as shown in Figure 5.

3. The monitoring of all schools in the district. This routine prints the school number in the district followed by the number of mathematics lessons and the number of reading lessons completed up to the moment the routine was called. An example of this output appears in Figure 6.

4. The alteration of individual student restart parameters. This routine allows alteration of any of the following parameters: time to be spent in any strand, time to be spent on the program in one session, location of the student in any strand (i.e., he may be moved forward or backward), and the status of the readiness flag which, if set, branches the student to the readiness strand before allowing him to continue in the curriculum. Significantly, it is now possible for students, or entire classes, to be branched into and out of experimental strands or any experimental situation which uses digitized audio and Model-33 teletypes.

6. Data Analysis

To summarize the progress of students participating in the reading program from May 1 through June 11 of this quarter, a series of cumulative reports were obtained for each class. As shown in Figure 5 in this report, the first, second, and third lines of numbers give, respectively, the average, minimum, and maximum values of the variable indicated in the column heading. The first column gives the accumulated time on the system. The columns headed L, W, Ph, Sp list current sections in the letter, word, phonics, and spelling-pattern strands, respectively.

CLASS 82 23 JULY 1969

7 STUDENTS MRS. DRISCOLL

ACC. MIN.	L	W	PH	SP		→ = KID HAS RUN TODAY
					1577	DALE HAMMON
73.6	18	15	7	3	1578	DEBBIE NAKAMURA
86.5	10	7	1	1	1579	→CYNTHIA PERKINS
41.2	10	8	2	1	1580	CYD PHILLIPS
48.6	12	9	1	1	1581	→GAIL PHILLIPS
72.3	14	11	2	1	1582	→LEONARD WILLIAMS
					1630	EASTER WILLIAMS
AVERAGES:						
64.4	13	10	3	1	BASED ON 5 STUDENTS	
MIN:						
41.2	10	7	1	1		
MAX:						
86.5	18	15	7	3		

Fig. 3. On-line utility program for class information, reading program.

CLASS 82 23 JULY 1969

7 STUDENTS MRS. DRISCOLL

ACC. MIN.	L	W	PH	SP	
73.6	18	15	7	3	
86.5	10	7	1	1	
41.2	10	8	2	1	
48.6	12	9	1	1	
72.3	14	11	2	1	
AVERAGES:					
64.4	13	10	3	1	BASED ON 5 STUDENTS
MIN.					
41.2	10	7	1	1	
MAX.					
86.5	18	15	7	3	

Fig. 4. Class information brief form, reading program.

```
CLASS 82          23 JULY L969

7 STUDENTS        MRS. DRISCOLL

ACC MIN.          L     W     PH    SP


AVERAGES:
    64.4          13    10    3     1    BASED ON 5 STUDENTS
MIN:
    41.2          10     7    1     1
MAX:
    86.5          18    15    7     3
```

Fig. 5. Class information summary, reading program.

```
SI3:2.49               SCHOOL TOTALS

SCHOOL                 M      R

  0                    5      4
  1                   28
  2                   14
  3                   11
  6                  164     42
  7                  362    149
  8                  230     50
  9                   80     15
 11                    7
 12                   70
 13                    1
```

Fig. 6. Daily lessons run in the district, reading program.

Tables 3 and 4 are compiled from the class summaries by pooling classes of the same grade at each school. Table 3 gives the mean section for each strand, rounded to the nearest whole section, by grade and school. Table 4 gives the corresponding maximum values. It should be noted that students who are never branched into the phonics or spelling pattern strands are, nevertheless, listed as being on the first section in these strands.

Generally speaking, performance in the reading curriculum reflects the student's grade placement. The first graders made more progress than the kindergarten students, and the second and third graders made more progress than the first graders. It is difficult to compare the performance of the few participating students who were in the fourth grade and higher with the third graders, because they spent less time on the program than the others. The lower performance of remedial students on this material may have been due entirely to the shorter amount of time they spent on the program. Table 5 gives the overall results by grade.

Table 6 gives the total time accumulated by the students at each school between May 19 and June 11. The accumulated time index was reset to zero for each student on May 19, when a programming error was corrected. The second column of Table 6 indicates the total time in terms of 8-minute student sessions per terminal at each school. The school highest on this index had been previously involved in a computer-assisted spelling project conducted by the Institute, and the second highest was involved in earlier phases of the reading project. Since there were effective, experienced proctors at these schools, it is not surprising that operations were more efficient.

C. Logic and Algebra Program

Most of the work during this period was concentrated on the second-year program. Printouts for the Teacher's Manual are now available up to Lesson 233, but the more important task of preparing the files for acceptance by the PDP-10 problem preprocessor has not yet been started.

TABLE 3

Mean Sections Attained in the Letter, Word, Phonics, and Spelling-Pattern Strands by School and Grade, Reading Program

	Grade																			
	K				1				2				3				4 and 5			
School	L	W	Ph	Sp	L	W	Ph	Sp	L	W	Ph	Sp	L	W	Ph	Sp	L	W	Ph	Sp
Belle Haven	4	2	1	1(46)*	8	3	1	1(23)	4	2	1	1(10)	5	2	1	1(19)		---		
Brentwood	6	2	1	1(115)	12	7	2	1(138)	15	12	3	2(107)	12	11	3	2(82)	6	4	1	1(14)
Costano	6	2	1	1(57)	4	2	1	1(44)	9	5	1	1(33)			---			---		
Flood			---				---				---		7	5	1	1(54)	5	4	1	1(6)
Kavanaugh			---				---		5	3	1	1(75)			---		4	1	1	1(5)
O'Connor	5	2	1	1(60)			---		11	6	1	1(4)	7	4	1	1(8)		---		
Runnymede			---				---		9	5	1	1(18)	12	8	2	1(13)		---		
Willow			---		11	6	1	1(30)			---		9	6	2	1(17)	5	2	1	1(10)

*Number of students at each school and grade.

TABLE 4

Maximum Sections Attained in the Letter, Word, Phonics, and Spelling-Pattern Strands by School and Grade, Reading Program

	Grade																			
	K				1				2				3				4 and 5			
School	L	W	Ph	Sp	L	W	Ph	Sp	L	W	Ph	Sp	L	W	Ph	Sp	L	W	Ph	Sp
Belle Haven	11	8	1	1	16	9	2	1	7	3	1	1	9	7	1	1		---		
Brentwood	18	7	1	1	18	23	10	8	18	24	13	13	18	21	8	7	12	8	1	1
Costano	17	11	2	1	11	4	1	1	14	12	1	1			---			---		
Flood			---				---				---		13	11	1	1	10	8	2	1
Kavanaugh			---				---		11	9	2	1			---		7	2	1	1
O'Connor	12	9	1	1			---		14	11	2	1	9	9	2	1		---		
Runnymede			---				---		14	9	2	1	15	11	3	1		---		
Willow			---		11	6	1	1			---		18	15	7	4	11	5	1	1

TABLE 5

Mean and Maximum Sections Attained in the Letter, Word, Phonics, and Spelling-pattern Strands by Grade, Reading Program

Grade	Number of Students	Means				Maximums			
		L -	W -	Ph -	Sp	L -	W -	Ph -	Sp
K	278	5	2	1	1	18	11	2	1
1	235	8	6	1	1	18	23	10	8
2	247	10	7	2	1	18	24	13	13
3	193	9	7	2	1	18	21	8	7
4 and 5	35	5	3	1	1	12	8	2	1

TABLE 6

Total Instruction Time from May 19 to June 11, 1969
by Grade, Reading Program

School	No. of terminals	Total instruction time in minutes	8-minute session per terminal
Belle Haven	6	3565.8	74.3
Brentwood	18	22925.1	159.2
Costano	4	5969.4	186.6
Flood	2	1893.4	118.3
Kavanaugh	4	2470.8	77.2
O'Connor	2	2210.8	138.2
Runnymede	2	1171.7	73.2
Willow	2	1923.2	120.2
All Schools	40	42130.2	105.3

Two substantial simplifications (first hinted at in the October-December 1968 Quarterly Report) were made in the curriculum. The point of both was to make the proving of theorems more straightforward.

1. Lemma Mode

   Lemmas have the same logical status as theorems. They are to be derived by the students and are available for instantiation thereafter. The main reason for the difference of terminology is that, in contradistinction to theorems, only the three most recently derived lemmas are available. Thus, useful results are labelled lemmas, rather than theorems, if they have no intrinsic interest, but are merely suitable rest-stops on the way to interesting theorems. No lemma list is provided, but the student may, during any derivation, obtain the list of three lemmas available by typing LEM. Should he wish to use say, Lemma A, he types LMA, and instantiation may proceed as with theorems and axioms.

2. Alteration of axioms and theorems

   Many proofs involving the axioms

   $$\text{MI} \quad \neg A = 0 \rightarrow A \text{ X } (1/A) = 1,$$
   $$\text{FR} \quad \neg B = 0 \rightarrow A/B = A \text{ X } (1/B)$$

   and the theorems derived from them were too long since, in the use of these axioms (and theorems), $\neg A = 0$ (or $\neg B = 0$, or some such inequation) had first to be assumed as a working premise; then AA had to be called on; and, eventually, CP had to be used. By replacing these antecedents by an informal injunction never to allow 0, or some term equal to 0, as the denominator of a fraction, we were able considerably to shorten many derivations (in one case, eight steps were excised).

Lessons that have been modified toward the top end of the curriculum are shown in Table 7.

TABLE 7

Simplified Version of Multiplication Axioms and Theorems

Lesson number	Topic
233	MI: multiplicative inverse axiom. A X (1/A) = 1, for A ≠ 0. Discussion of the case where A = 0. Theorem 31: (1/A) X A = 1, for A ≠ 0.
234	U: unity axiom. ¬1 = 0. IP: indirect proof.
235	Contraposition. Continuation of story begun in 224. FR: A/B = A X (1/B), for B ≠ 0. Theorem 32: 1/1 = 1. Theorem 33: A/1 = A. Theorem 34: A/A = 1, for A ≠ 0.
236	Use of parentheses with connectives. Review of: LC, left conjunct; RC, right conjunct; FC, form a conjunct.
237	MS: associate multiplication axiom. (A X B) X C = A X (B X C). MR: associate multiplication right. ML: associate multiplication left. Theorem 35: A/B = C → A = C X B, for B ≠ 0.
240	DL: distributive axiom. A X (B + C) = (A X B) + (A X C). Theorem 36: (B + C) X A = (B X A) + (C X A). More about fractions. Theorem 37: A X 0 = 0. Theorem 38: ¬1/A = 0, for A ≠ 0.
241	Story. Theorem 39: 0/A = 0, for A ≠ 0. Theorem 40: A X B = 1 → B = 1/A, for A ≠ 0. Theorem 41: ¬A = 0 & A X B = A → B = 1.
242	Some fun and games. Theorem 42: (A/B) X C = (A X C)/B, for B ≠ 0. Theorem 43: (A/B) X C = (C/B) X A, for B ≠ 0. Theorem 44: (A/B) X (C/D) = (C/B) X (A/D), for B, D ≠ 0. Thereom 45: (A/B) X (B/A) = 1, for A, B ≠ 0. Introduction of Lemma procedure.

TABLE 7 (continued)

Lesson number	Topic
243	Theorem 46: $\neg A = 0 \ \& \ A \times B = A \times C \rightarrow B = C$. Theorem 47: $\neg A = 0 \ \& \ A \times B = 0 \rightarrow B = 0$. Theorem 48: $\neg A \times B = 0 \rightarrow \neg A = 0 \ \& \ \neg B = 0$. Theorem 49: $\neg A = 0 \ \& \ \neg B = 0 \rightarrow \neg A \times B = 0$.
244	Theorem 50: $B/(A \times B) = 1/A$; Theorem 51: $(C \times B)/(A \times B) = C/A$, for $A, B \neq 0$.
245	Theorem 52: $A/B = C/D \rightarrow A \times D = C \times B$, for $B, D \neq 0$. Theorem 53: $A = B \times C \rightarrow A/B = C$, for $B \neq 0$.
246	Theorem 54: $A \times (-B) = -(A \times B)$. Theorem 55: $(-A) \times (-B) = A \times B$.

D. Second-year Russian Program

1. Curriculum

During this quarter, 113 second-year Russian lessons, including review lessons, were completed and entered into the computer. Homework and study sheets for Lessons 86 through 107 were prepared and distributed to the students. The homework followed the pattern established during the first quarter. Quizzes and pronunciation sessions followed the pattern of the first quarter.

Computer-based tutoring in reading was abandoned and replaced by outside reading.

2. Data Analysis

Gathering of data continues as in the first and second quarters. Programs written for the PDP-10 are just now being debugged. New programs are being completed for the data analysis on the PDP-10 and the preliminary analysis should be available in the fall.

Fifty per cent of the final examination for the spring quarter was identical for the computer-based and for the regular sections. Table 8 shows the results of the examination. It should be noted that while the mean number of errors is only slightly less for the computer-based group than for the regular group, the regular section contained only 6 students during the spring quarter, while 15 students took the final examination in the computer-based section.

Since the original enrollments at the end of the autumn quarter were 19 for the computer-based group and 11 for the regular group, the computer-based group proved superior in terms of the total number of students who successfully completed the three-quarter sequence.

TABLE 8

Common Portion of the Third-Quarter Final Examination
Russian Language Course, 1968-69

Computer-based group		Regular group	
Errors	Students	Errors	Students
7	1		
$8\frac{1}{2}$	2		
10	1		
$12\frac{1}{2}$	1	$12\frac{1}{2}$	1
15	2		
$15\frac{1}{2}$	1		
$17\frac{1}{2}$	1		
18	1	18	1
		19	1
$19\frac{1}{2}$	1		
		$21\frac{1}{2}$	1
		23	1
$23\frac{1}{2}$	1		
24	1		
		$25\frac{1}{2}$	1
$32\frac{1}{2}$	1		
38	1		
Total students	15	Total students	6
Total errors	265	Total errors	119.5
Mean errors	17.7	Mean errors	19.9

E. Computer-assisted Instruction in Programming: AID

Since the first year of the AID project has now ended, this report includes a review of the goals and a progress report of these goals.

Further, the regular progress report for the months April through June is included.

1. Review of Goals

The major goal of the project is to develop a system for teaching computer programming (in particular, the programming language AID) by computer-assisted instruction. The course is completely self-contained and is directed at students of about junior college ability. As plans for the system developed, it became clear that the major goal implied two subsidiary goals: the development of the curriculum and the development of the program to control curriculum flow.

Students communicate with the computer through standard teletypes which are connected to the computer by telephone lines. The computer in its role as teacher presents instructions and problems to the student by typing on his teletype, the student responds by typing on the same teletype, and the response is relayed to the computer and analyzed. After analyzing the student's response, the computer replies, correcting the student if necessary and presenting him with additional instructions. At the same time the computer must handle simultaneously large numbers of other students, who may be taking the same course, or who may be enrolled in completely independent courses (computer-based Russian, for example.) The computer must work in a time-sharing mode.

The computer-assisted course may, of course, use supplementary materials such as reference manuals for the programming language being taught. Nevertheless, the course, including the supplementary materials, should be self-contained in the sense that it is independent of lectures or other instruction and does not require the presence of an experienced teacher of programming.

2. Summary of the Year's Activities

In planning the system to teach programming, we felt that the relatively mature students who would be enrolled in the course would be capable of making decisions about the course of study and also would be motivated by being permitted to make such decisions. Thus, no arbitrary remedial branching structure was incorporated in the system; in its place, the curriculum advises students to review previous lessons, to complete certain sets of practice or remedial

exercises, or to skip lessons that are either too easy or too difficult. The student may choose to follow the advice in the lessons or to ignore it, since he can control the sequence of problems by the use of a few simple "control commands."

Although major branching structure is imposed on the student, there is a rather complex system of "micro" branching within each problem. After a problem statement is presented by the computer, the student may make a number of different kinds of responses; for example, he may request additional instruction; he may demand the correct answer; he may skip a problem and go on to the next one; he may request any other problem in the course; he may, of course, type the correct answer; or he may type an incorrect response. For each case, the computer provides a different response. Since the system can make fine discriminations between student responses, each problem takes on the aspect of a little "conversation." This conversation may develop into a dialogue of some length, depending upon the number of messages supplied by the writer.

As plans for the system developed, it became clear that the major goal implied two subsidiary goals: the development of the curriculum and the development of a set of programs which would interpret the lessons and interact with the students.

The curriculum. The course in AID programming was planned as a series of lessons presenting the fundamentals of computer programming in the context of an introduction to the programming language AID. AID[1] (Algebraic Interpretive Dialogue) is a high-level algebraic programming language with extensive interactive (or "conversational") abilities. This language is an adaptation for the PDP-10 computer of JOSS,[2] a language developed by RAND Corporation for use by scientists, engineers, etc., who needed a powerful, easy-to-learn tool capable of performing complex algebraic tasks.

It was assumed that students would have no previous experience with programming or computers, although a certain facility with algebra (as supplied by a good course in high school algebra) was necessary. The more esoteric algebraic concepts, such as hierarchy of operations, zero exponents, and

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[1]See PDP-10 AID Programmer's Reference Manual, Digital Equipment Corporation, Maynard, Massachusetts. 1968.

[2]See Mark, S.L. and Armerding, G.W., The JOSS Primer, The RAND Corporation, Santa Monica, California. August, 1967.

Shaw, J.C., JOSS: Experience with an Experimental Computing Service for Users at Remote Typewriter Consoles, The RAND Corporation, Santa Monica, California. May, 1965.

conditional definitions of functions, are reviewed in the course. Necessary concepts from logic are also included. Certain features of AID, such as transcendental functions and recursive definitions of functions, are of little use to students who have not had an introduction to calculus or modern algebra; such lessons are optional and should be bypassed by most students.

An outline of the AID course is given in Table 9.

In addition to the programmed lessons, a reference manual is available for students that contains an outline and brief description of the lessons, additional programming problems, etc.

Of the 50 lessons which constitute the introductory course, 33 have been written and 23 coded; the first 2 lessons have been revised, and plans have been made to revise Lessons 3 to 20. This revision is based on a small-scale pilot study conducted during the spring of 1969. The preliminary version of the student manual has been written and was used by students; plans for a revision of the manual have been made.

The instructional system. In order to implement the planned curriculum, it was necessary to develop a lesson coding language, an interpreter program, and a supporting preprocessor system. The major activity of the year was the design of this set of programs and the production of a preliminary version of the system, referred to as the "interim system" in previous reports.

The interpreter ("teaching program") interacts with students at the time they are working on a lesson. This interpreter must be able to interpret the instructions given it by the curriculum writer and to use that information to determine which problem to give the student, how to analyze his response, and how to react properly to that response.

The instructions given to the interpreter by the writer must, of course, be in a simplified "code" which can be understood by the interpreter, hence a necessary part of the instructional system is a rigorously defined, unambiguous, coding language. The coding language, which may be used by relatively inexperienced personnel, had to be easy to learn and easy to use and preferably related closely to the English language. In other words, the coding language had to be a genuine higher-level programming language.

TABLE 9

Lesson Outline

Computer-assisted Instruction in Programming: AID

Lesson	Content
1	How to answer. How to erase. Control commands.
2	Signing on and off AID. The TYPE command. Arithmetic operators: +, -, *, /. Decimal numbers.
3	Using AID for arithmetic. Use of parentheses. Order of arithmetic operations.
4	The operator ↑ for exponentiation. Order of operations. Scientific notation.
5	Variables. The SET command. Redefining variables. The DELETE command used to delete variables.
6	Self-test.
7	Review.
8	The LET command (using function notation). Distinction between LET and SET. Distinction between use of a defined function and display of the formula for a function. Redefining and deleting functions.
9	Some standard AID functions: IP(x), FP(x), SGN(x), SQRT(x).
10	Indirect steps. DO STEP .... DO STEP.... FOR .... Redefining steps and deleting steps. TYPE STEP ....
11	Parts. DO PART .... DO PART .... FOR .... Deleting parts. TYPE PART.
12	The DEMAND command. DO PART ..., ... TIMES. Termination by refusal to answer a DEMAND command.
13	Self-test.
14	Review.
15	Relations between numbers. Relational symbols: < > , <= , >= , = = . Number line. The IF clause.
16	Branching. The TO command. TO STEP .... TO PART ....

Table 9 (continued)

Lesson	Content
17	Traces.
18	The indirect use of DO.
19	How to write and debug a program.
20	Self-test.
21	Review.
22	The FORM statement.
23	Loops.
24	Loops with variable bounds.
25	Loops compared with FOR clauses.
26	Loops with a DEMAND command.
27	Self-test.
28	Review.
29	Absolute value.
30	Trigonometric functions: SIN(x), COS(x).
31	EXP(x), LOG(x).
32	Lists.
33	Using loops with lists of numbers.
34	Self-test.
35	Review.
36	More on loops. Decrementing counters. Formulas for exit condition.
37	Iterative functions: SUM, PROD, MAX, MIN.
38	Arrays. LET S BE SPARSE.
39	Conditional definition of functions.
40	Recursion.
41	Self-test.
42	Review.
43	AND, OR and NOT. Truth tables.
44	TV(x). The function FIRST.
45	LET used to define propositions.
46	More standard AID functions.
47	More about lists and arrays.
48	Self-test
49	Review.

The interpreter had to be written to interpret this coding language directly. However, since response time is such a critical concern in the design of any interactive system, it was desirable to have the coded lessons put through at least one intermediate translation to transform the code into a language more readily understood (or at least, more rapidly understood) by the interpreter. Thus, a system of intermediate translation, or "lesson preprocessing," was desirable. The lesson preprocessing can then be done before a student begins a lesson, perhaps the evening before or perhaps months before, with a significant beneficial effect on the response time of the interpreter.

During the year, the specifications for the instructional system were written, a preliminary version of the coding language was developed, and the programs for lesson preprocessing and for interpreting were written, debugged, and used by students in the pilot study.

Based on experiences of coders and students, plans were made for a revision and extension of all components of the instructional system. The new instructional system is now being prepared; a detailed description is given in Section 4 of this report.

As the instructional system developed, it became evident that although the AID programming course would be the first application of the system, the system was equally well suited to teach any programming language, or indeed to teach almost any other subject amenable to computer-assisted instruction. The system is not well suited for drill and practice or for experimental use where a more rigid branching structure is desired. Nor is it equipped with the peripheral apparatus (audio, visual displays) necessary for subjects such as foreign languages or art. However, any subject which is primarily conceptual and which may be taught verbally is an ideal candidate for computer-assisted instruction using this teaching system. An effort has been made throughout the design and implementation of the instructional system to maintain this generality.

3. The Pilot Study

A small pilot study was designed during the Spring Quarter, 1969, to supply information for meaningful revisions of the curriculum and the instructional system. Since this was the first run of the system, we felt the most useful information would be derived from students' reactions to the program. There was no plan to collect detailed data or to perform any kind of statistical analysis of the data. Ten students were enrolled in the course on a flexible time scheduling

basis; some students took three sessions a week, others two, and others came only once a week, depending upon individual preferences. The students were allowed to use the course in whatever way they felt best; but were restricted to taking no more than two lessons per session. Also, immediately after each session they were to be interviewed for 5 to 10 minutes.

The students completed anywhere from three to twenty lessons each; about half of them progressed as far as Lesson 20. In general, the students who completed fewer lessons did so because they spent less time on the lessons rather than because of any difficulty with the material. In fact, the student who had the most difficulty with the course, and who made the slowest progress in relation to the time spent, finished Lesson 13 by the end of the quarter and expressed regret that he had not been able to spend enough time to have completed the 20 available lessons.

Students were timed on several lessons in order to get a rough idea of the time needed for future students to complete the course. The average time per problem for different students ranged from one minute per problem to three minutes per problem; the assignments for each lesson required about as much time as the lesson itself.

Extensive notes were taken during interviews with the students and were summarized in a weekly report. Also, the responses to individual problems were tabulated and the percentage of correct and incorrect responses was calculated. The most frequent incorrect response to each problem was also tabulated.

The students were enthusiastic about the course and would have worked for several hours at a time had they not been restricted to taking no more than two lessons per session.

Since most of the students' comments were about specific problems, we did not feel that a major revision of the curriculum was needed. The following are a few general observations based on students' comments and behavior.

Use of student controls. The student control commands, which were explained in detail in Lesson 1, were received with enthusiasm. (A control command is given by holding down the "CTRL" key while striking a letter key.) The commands used were:

Ctrl-H (requests a hint)

Ctrl-T (requests the answer)

Ctrl-S (skips to next problem)

Ctrl-G (gets another problem or lesson. After the student types Ctrl-G he is asked to specify the lesson and problem he desires.)

Both Ctrl-H and Ctrl-T were used frequently, although there was a noticeable tendency to use one or the other but not both. Ctrl-S was rarely used; in fact, when several students were asked, at the end of Lesson 3, what control commands were available, they were not able to recall Ctrl-S.

Ctrl-G was used much less than anticipated. At the end of the pilot study, the students were queried about this; several students replied that they thought they would not be contributing fully to the experiment (the pilot study) if they skipped any of the lessons; a few felt they would not know what they had skipped and that it might be important to them in later lessons (this comment was made even in reference to reviews and self-tests in which there had been an explicit statement that no new material would be presented and that it was perfectly acceptable to skip the entire lesson); only one student consistently chose to review previous lessons, and he commented that he felt he simply repeated the same mistakes without achieving any noticeable gain in understanding.

Language confusion. Almost all students evidenced some confusion between the language they were learning (the AID programming language) and the language (English) used in the exposition. Part of this confusion undoubtedly arose because the AID language is a subset of English (AID commands are syntactically correct English sentences that contain a verb and end with a period, etc.). Although this is certainly not a complete explanation, it is obvious that the advantages of teaching an English-based programming language far outweigh the disadvantages even it it could be shown to be a significant factor in the language confusion.

Furthermore, a few students were also puzzled about which program they were using--the teaching program or the AID interpreter (which they used for doing assignments); one student tried to ask the AID interpreter for hints about an assigned programming problem. We feel that some confusion between languages and between programs is almost inherent. So far, no satisfactory way of dispelling the confusion has been found.

Constructed responses to multiple-choice problems. The multiple-choice problems used in the course consist of a problem statement or question and a list of possible answers, each of which is labeled with a letter. For example,

WHICH OF THESE ARE CORRECT AID COMMANDS ?

A. TYPE 2 X 3.

B. PRINT 2 * 3.

C. TYPE 2 * 3.

N. NONE OF THE ABOVE.

Students are expected to respond by typing a letter (or list of letters) corresponding to the correct answer (or answers).

There is a noticeable tendency for students to respond to certain multiple-choice problems by typing the answer itself rather than typing the corresponding letter. In the AID course, a response other than a single letter (or list of letters) is treated as an error, and the message PLEASE TYPE LETTERS ONLY is given. This error message has been found to be remarkably ineffective; the probability that a student will repeat the same kind of error after receiving the above error message seems to be greater than one half and possibly as much as three quarters.

The tendency to make the kind of error described above seems to be influenced by the following factors:

1. Answer length. If the number of characters in the answer choice is small (say, two to six characters), there is a strong tendency to type the answer itself.
2. Context. If the problem is preceded by several problems requiring constructed responses, the tendency to construct a response is somewhat increased. If the preceding constructed responses are closely related to the choices in the multiple-choice problem, there is an even stronger tendency to construct a response; for example, if the six preceding problems require 3-digit numbers as a response, and the choices in the multiple-choice problem are 3-digit numbers, there is a high probability of making an error.

3. Problem-solving strategy required. There seem to be two distinct kinds of problem-solving strategies used in producing the answer to a multiple-choice problem. One is a "mental construction" of the correct answer, followed by a search of the choices for that answer and the other is a "feasibility-elimination" approach in which the student inspects the list of possible answers and chooses that which is most feasible, or eliminates those which are least feasible. (Generally, students working on a specific problem will not switch from one strategy to another unless there is a compelling reason; for instance, a student will abandon a "feasibility-elimination" approach if several choices are equally feasible.) The strategy a student uses is influenced by the problem statement, although there is some tendency for individual students to prefer one strategy over another. If the "mental construction" strategy is used, the student is more likely to produce an overt construction of the answer, thereby producing an "error."
4. Wording used in problem statement. The wording used in instructions to to the student seems to have some effect on the tendency to give a constructed answer to a multiple-choice problem. In particular, use of the word "what" in the problem statement produces more errors than the word "which." For example, compare "What command causes AID to give N a value of 12?" with "Which command causes AID to give N a value of 12?"

One additional comment: Although the above remarks may imply that the error of constructing a response in answer to a multiple-choice question is a use-mention error, this may not be the case. There are a number of problems in the course which require a "partial construction" and there is an observable tendency in students to give a more complete answer than is required; for example, students tend to answer "Do Part 12." rather than "Do" in response to this problem:

COMPLETE THIS COMMAND TO
EXECUTE PROGRAM 12.
..... PART 12.

The error of constructing a more complete response than required is clearly not a use-mention error, and it seems to be closely related to the error of constructing a response to a multiple-choice problem.

Answer length, context, required strategy, and wording used in problem statement are not the only factors which contribute to the kind of use-mention error under consideration here; there are also individual factors, such as age and previous experience. However, the above four factors are the only curriculum-oriented factors which seem to have an effect.

4. Other Activities of the Past Quarter

In addition to conducting a pilot study, the staff continued writing lessons, coding, and debugging.

A major revision of the coding language was made and work on the time-shared version of the instructional system was started. The revised instructional system will be discussed in detail in the next quarterly progress report.

F. Computer-assisted Instruction in Programming: SIMPER and LOGO

1. The Classroom

As of April 7, Collins Data Sets were provided at Woodrow Wilson High School to make 12 of the 15 terminals operable. The PDP-8i, scheduled to control the 15 teletypes, did not arrive until late April, at which time one month's work was necessary to fit the machine into the Institute's computer system. Thus, we decided to delay installation of the PDP-8i until just before the fall semester.

Throughout this period, six classes of 15 students each continued to meet for 50 minutes per day. About 6 students continued the course without credit during their lunch hours, and the two adult education classes still met Tuesday and Thursday evenings. By the time the course ended on June 11, several students had completed the 38 SIMPER lessons and 19 LOGO lessons. Most students had completed all of the SIMPER lessons and 5 to 10 of the LOGO lessons.

The teachers and several students made detailed comments on the lessons they studied each day. These comments, together with those from teacher conferences, discussions with students, and talks with Stanford staff provided the basis for curriculum revisions for the fall.

Students who took the course were anxious to take a second-year course in the fall. Therefore, AID,[3] a course developed by Mrs. Jamesine Friend (see

[1]AID, Algebraic Interpretive Dialogue is an interactive programming language based on JOSS and implemented by Digital Equipment Corporation for PDP computers.

information on the AID project in this and previous progress reports) will be offered. Thus, two AID classes and six SIMPER-LOGO classes, as well as the two adult education classes will be available in the fall.

Because of the decision to offer AID, it will be necessary to convert the teletype keyboards from the IMSSS version to the standard ASCII keyboards. The conversion will be made over the summer, and the revised curriculum will reflect the change.

2. The Curriculum

The first 19 LOGO lessons and associated tests and homework assignments were written and debugged. It was decided to postpone writing further LOGO lessons for the current year when it became clear that at most one student would complete all 19 lessons.

Revised outlines were prepared for both SIMPER and LOGO, as shown in Tables 10 and 11. The 40 lessons were also rewritten. The structure of all the lessons was changed to take advantage of the new coding language which will be available under the control program we will be using on the PDP-10 in the fall. For details on the driver and coding language, see Section F of this report.

Generally, the revisions attempt to give the student a clearer idea of the distinction between the teaching program, which presents lessons about a programming language, and the language itself, in which the students write programs directly. In SIMPER, certain instructions were given new names, at the suggestion of the teachers. The method of addressing was simplified, and the test instructions SKIPE and SKIPN were added. The more complex test instruction, CMP was introduced in a lesson towards the end of the course. The revised lessons reflect these changes, which will be made when SIMPER is put on the PDP-10.

In the revised LOGO lessons, abbreviations for certain commonly used instructions were introduced earlier. The test instruction IS was changed to one called SAME ? . By modifying the definition of IS, we can use the same format for all five test instructions (SAME?, WORD?, SENTENCE?, NUMBER?, and a new one, GTR?). The tests are all to be used with the IF-THEN-ELSE command, in which the ELSE clause is optional.

During this period, the first three lessons for both LOGO and SIMPER were coded using the new coding language for the PDP-10 lesson driver.

TABLE 10

Outline of SIMPER Lessons, Lessons 1 to 20

Lesson	Description
1*	How to use the teaching program. Use of control commands.
2	Instructions FIX and STOR.
3	Instructions BEGIN, END, and PRINT
4	Stored programs. How and why they are used.
5	Review.
6	Signing on to SIMPER. Learning to write programs directly in SIMPER.
7	The instruction ADD. Writing, executing, and debugging programs using ADD.
8	The instruction LOAD.
9	The instructions MUL, SUB, and DIV.
10	Review.
11	The instruction PUTIN, to allow data input during execution.
12	Writing SIMPER programs to solve problems.
13	The instruction JMP.
14	Negative number. How to input negative numbers in SIMPER.
15	Review.
16	Writing programs involving more than one operation.
17	Equivalent programs. Writing two programs that produce the same result. Evaluating which is "better."
18	Use of register B.
19	How DIV uses two registers.
20	Review.

*To be omitted by students who have previously studied LOGO.

TABLE 11

Outline of LOGO Lessons, Lessons 1 to 20

Lesson	Description
1*	Introduction to the teaching program. Use of control commands.
2	Introduction to LOGO; the instruction PRINT. Definition of a LOGO "word," "sentence," and "number."
3	The instructions WORD and SENTENCE.
4	The instructions FIRST and BUTFIRST.
5	Review.
6	The instructions LAST and BUTLAST.
7	Introducing compound commands.
8	Additional work with compound commands.
9	Signing on to LOGO; writing programs directly in LOGO.
10	Review.
11	The arithmetic instructions SUM, DIFFERENCE, TIMES, and QUOTIENT.
12	Using LOGO to solve problems involving negative numbers.
13	The instruction CALL: how to assign names.
14	Practice using CALL with other commands.
15	Review.
16	The instructions SAME? and IF-THEN-ELSE. SAME? is used with IF-THEN-ELSE to test whether two words, sentences, or numbers are identical.
17	The LOGO tests WORD?, SENTENCE?, and NUMBER ? .
18	The LOGO test GTR ? .
19	Nesting: using more than one IF-THEN-ELSE statement in a single command.
20	Review.

*To be omitted by students who have previously studied SIMPER.

3. Systems Programming

The lesson driver, SIMPER, and LOGO were continually debugged and refined during this quarter.

Work was started on the lesson preprocessor for the PDP-10, and transfer of SIMPER and LOGO to the PDP-10 began. The lesson driver for the PDP-10 is described under "AID project" of this report and previous ones. It is being developed and written by Mrs. Jamesine Friend. Mrs. Phyllis Sears has been consulted regarding amount of student control, arrangement of lessons, the coding language, etc.

G. Stanford PDP-1/PDP-10 System

1. Hardware

The digitized audio system on the PDP-10 was put into routine operation by furnishing audio for the Ravenswood reading program.

Interface work was completed for the Inktronic printer that was delivered by Teletype Corporation. This unit was attached to the PDP-10 high-speed data communications multiplexor and is operated by the computer as if it were another high-speed telephone line.

The IBM 2803 tape control and two 2401 Model-IV tape drives were installed and connected to one of the existing disk data channels on the PDP-10. No new interfacing hardware was required, since the disk interface hardware was designed to simulate a general-purpose IBM 360 selector channel. Troubles were encountered, however, in that the original set of connecting cables was defective and the channel cable connecting board on the tape control was wired backwards. Until the latter problem was traced and the control unit rewired by IBM, numerous disk errors were experienced on the 2314 connected to the same channel, because of improper electrical termination of the cables common to both units. The tape units have now been in successful operation for several weeks and are used to save the on-line data recording files generated each day by the instructional programs.

While the system as a whole is now quite stable, temporary disruption of service during the quarter was caused by minor circuit failures in the memory system, PDP-10 CPU, and several data channels.

2. Software and Operations

Huffman coding was applied to the outbound transmissions on the high-speed data lines. The PDP-10 transforms the normal ASCII teletype characters into this condensed, variable-length encoding, which is then decoded back into ASCII by the remote PDP-8's. This technique allows many more teletypes to be operated from a single high-speed line. Incoming characters are still transmitted in ASCII, as the lower character rates in this direction are well below the data-line capacity.

Various improvements were made in the software communication facilities between the PDP-1 and the PDP-10. Files prepared on the PDP-1 can easily be copied over to the PDP-10 file system, and user-mode programs running on both machines can send messages to each other for real-time coordination.

Several programs were written to test and exercise the new magnetic tape drives, and a utility routine was prepared to allow saving PDP-10 files on tape.

During this period of increasingly stable operation on the PDP-10, record loads of over 6,000 students per day were reached.

The decision was made during the quarter to adopt the new Series 4 time-sharing monitor distributed by DEC for the PDP-10. Listings and tapes for this system were ordered and received by the end of the quarter. Many modifications will be required before the unit can be used on the Stanford machine, including additional features relevant to the CAI application. This system, however, is designed to allow re-entrant programming using the double relocation registers on the machine and employs full-duplex operation for teletype terminals.

II. Activities Planned for the Next Reporting Period

A. Drill-and-practice Mathematics Program

The strands program will be encoded and tested for use in 1969-70. Final revisions will be made and reports for teachers and staff will be defined formally in terms of content and format and programmed.

Work will begin on the expansion of the remedial college-level mathematics program used this past year at Tennessee A. and I. State University. Lessons for a second quarter will be planned and writing will begin.

It is hoped that work with culturally deprived and handicapped children will continue to expand. One teletype terminal will be placed in a school for the educationally handicapped in September. Also, groups who have English as a second language will be encouraged to participate, particularly in the San Jose area where preliminary efforts have been successful.

B. Drill-and-practice Reading Program

Data from the 1969 Ravenswood summer school program will be analyzed to determine for each of five groups (pre-schoolers, first graders, second graders, third graders, fourth graders and up) which curriculum sections in each strand are the most difficult and which are the easiest, how long it takes to complete each exercise in each of the strands, and whether any sex differences in performance exist on the reading program.

The reading program will be made compatible with the DEC time-sharing monitor and will be as independent of the generalized driver as possible. The word-meaning strand, strand 5, will be incorporated into the reading program and additional second- and third-grade items will be included in the program. Routines for efficient analysis and retrieval of data will continue to be developed.

C. Logic and Algebra Program

The revisions and reprogramming of the logic and algebra program will continue and is expected to be completed. These programs will include the new counterexample modes for logic and algebra. It is expected that the programs will be checked and thoroughly debugged by the end of the next reporting period.

Revisions and reprogramming of the curriculums should also be completed. These must accommodate the minor changes in coding formats and the proposed switch to English-word usage instead of the symbolic connectives.

D. Second-year Russian Program

The second-year course will be revised and will concentrate solely on the teaching of new grammar and vocabulary. No attempt will be made to include the reading of extensive texts in the course format.

A preliminary analysis of the data on student performance will be included in our final report. The full text of the revised lessons will be printed out and stored at IMSSS where it will be available for inspection by interested scholars.

E. Computer-assisted Instruction in Programming: AID

During the next three months, detailed plans for a revision of the curriculum will be made, some of the lessons will be rewritten, and lesson coding (using the revised coding language) will commence.

A coders' manual for the new coding language will be written.

The major effort in the next three months will be the preparation of programs for the revised instructional system. The two major programs, the lesson driver and the lesson preprocessor, will be written first; supporting programs, such as the student enrollment program, the data collector, will not be written until the major programs are completed.

F. Computer-assisted Instruction in Programming: SIMPER and LOGO

Next quarter, the lesson driver and preprocessor will be completed and debugged. SIMPER will be revised and transferred onto the PDP-10. The PDP-8i will be installed in Woodrow Wilson High School, and the teletypes at the school will be converted to the standard ASCII keyboard.

The remaining SIMPER lessons, tests, and homework assignments will be written. The first 25 to 30 of these lessons will be coded and debugged. The student manuals and teacher manuals will be revised. In late August, a one-week workshop will be held to familiarize the teachers with AID.

G. Stanford PDP-1/PDP-10 System

Summer-school students will be run on the PDP-10 until August 1. After that date, the machine will be down for approximately two weeks to allow DEC engineers to install the second set of relocation registers on the PDP-10 central processor.

Virtually all software efforts will be devoted to getting the new Series 4 monitor operational by the fall school term and modifying the application programs to utilize the features of the new system.

III. Dissemination

A. Lectures

Atkinson, R. C. Human memory and the concept of reinforcement. Invited address given at the Nature of Reinforcement Conference, Pittsburgh University, Pittsburgh, June 10-11, 1969.

Atkinson, R. C. A theory of memory and its application. Invited address at the WPA Convention, Vancouver, British Columbia, June 18-20, 1969.

Fletcher, J. D. The Stanford initial reading programs. Lecture presented to the NDEA Institute for Advanced Study in Reading-Secondary, California State College, Hayward, May 8, 1969.

Jerman, M. Some promising developments in CAI. Paper presented at the annual meeting of the Association for Educational Data Systems, Portland, Oregon, May 9, 1969.

Jerman, M. Computer-assisted instruction. Lecture presented at the annual In-service Workshop of Supervisory Personnel, Ohio State Department of Education, The Neil House, June 13, 1969.

Jerman, M. New developments in CAI. Lecture presented at a Conference on Programmed Instruction and Computer-assisted Instruction, San Diego County Department of Education, San Diego, June 19, 1969.

Jerman, M. Computer-aided instruction. Lecture presented at the Symposium on Education and Information Science, Hitchcock Hall, Ohio State University, June 23, 1969.

Jerman, M. CAI workshop. Seattle teachers and University of Washington staff of the Experimental Education Unit, Seattle, Washington, June 27, 1969.

Smith, R. W. Computers in education. Lecture presented to Seminar on Computers in the Social Sciences, Department of Sociology, Stanford University, May 29, 1969.

Suppes, P. Educational technology and the teaching of philosophy. Invited lecture presented at annual meeting of Western Conference on the Teaching of Philosophy, Cleveland, Ohio, May 1, 1969.

Suppes, P. Chairman, Symposium on Computer-assisted Instruction Problems and Prospects, Spring Joint Computer Conference, Boston, Massachusetts, May 15, 1969.

Suppes, P. Programming and problem-solving. Lecture presented at session on Human Uses of Computers for Education, American Federation of Information Processing Societies, Boston, Massachusetts, May 16, 1969.

Suppes, P. Panel member on the Feasibility and Economics of Using Computers in Schools. Session on Human Uses of Computers for Education, American Federation of Information Processing Societies, Boston, Massachusetts, May 16, 1969.

Suppes, P. Lectures presented as Britannica Scholar in The Information Science Year Lecture Series, The University of Chicago, May 23, 26, and 28 respectively:

Stimulus-response theory of finite automata;
Probabilistic grammar for children's speech; and
Use of mathematical models of learning in computer-assisted instruction.

B. Publications

Atkinson, R. C. Storage and retrieval process in long-term memory. Psychological Review, 1969, 76, 179-193. (with R. M. Shiffrin)

Atkinson, R. C. Recognition vs. recall: Storage or retrieval differences? Quarterly Journal of Experimental Psychology, 1969, 75, 183-184. (with R. D. Freund and J. W. Brelsford, Jr.)

Atkinson, R. C. Applications of multiprocess models for memory to continuous recognition tasks. Journal of Mathematical Psychology, 1969, 6, 576-594. (with R. D. Freund and G. R. Loftus)

Atkinson, R. C. Repetition vs. imagery instructions in the short- and long-term retention of paired-associates. Psychonomic Science, 1969, 15, 183-184. (with John Schnorr)

Atkinson, R. C. Human memory and the concept of reinforcement. Technical Report No. 145, May 20, 1969, Stanford University, Institute for Mathematical Studies in the Social Sciences. (with T. D. Wickens)

Jerman, M. Characteristics of CAI configurations from an author's viewpoint. In Ralph Heimer (Ed.), Computer-assisted instruction and the teaching of mathematics. Washington, D. C.: The National Council of Teachers of Mathematics, 1969. Pp. 24-44.

CAI NEWSLETTER

INSTITUTE FOR MATHEMATICAL STUDIES IN THE SOCIAL SCIENCES
STANFORD UNIVERSITY

Vol.I., No. 2 February 1969

The switchover to the PDP-10 has begun. The first phases are completed. From now on the operation should become smoother each week. Already larger numbers of students are running each day. One new feature recently added to the program is the "sign-off." To terminate any student's lesson, simply wait until he has completed a problem, then hold down the "control" button and press the "s" key when the program is ready for the first answer from the following problem. The student may then leave for the day if he wishes. When he signs on again, his lesson will begin where he was signed off.

Other new features will be announced soon. Teachers will soon be able to get on-line reports of individual student's performance and other things.

New Schools

We are happy to welcome two more schools into the program this year. One teletype is located in Columbus, Ohio and operated by the Franklin County School District. The Clinton, Iowa Job Corps is the second "new" school, although they were in the program last year. The Clinton Job Corps Center is a school for girls, operated by the General Learning Corporation.

Although not a new "school," we are happy to welcome the Motorola Scouts of Scottsdale, Arizona. This explorer troop, sponsored by Motorola Aerospace Center, will take periodic lessons on a single teletype. They are interested in learning about electronics and CAI hardware.

School of the Month

We are featuring Peter Burnett Junior High School and Mr. Jim Moriel, Vice Principal and Director of CAI for the San Jose Unified School District in this issue. Peter Burnett is one of the older schools, located in the north central section of San Jose. The school population is approximately 77% Mexican-American, the remainder of the population is composed of Negro, Japanese, and Caucasian students.

Mr. Moriel has done an excellent job scheduling students so that the program at his school is one of our most efficient operations. Morale among the project students has been very good. The faculty has been most enthusiastic and cooperative. A preliminary report of student achievement at Peter Burnett has been prepared for this issue by Mr. Moriel.

* * *

Overhead in a teletype room one day: Jimmy to John, while pointing to a teletype, "Don't use that teletype, it gave me hard problems yesterday."

Vol. I., No. 2 February 1969

A Preliminary Evaluation of CAI at Peter Burnett

The CAI program of drill and practice in the fundamentals of arithmetic began at Peter Burnett Junior High on October 9, 1967. There were sixty-four students selected to participate in the program. Of those selected, approximately 25% were seventh graders, 50% eighth graders, and 25% ninth graders. The students were selected on the basis of demonstrated need as reflected by their achievement scores, reading scores, teacher opinions and past grades in mathematics. The average reading scores ranged from 2.5 to 4.5 G.E. (grade equivalent). Each student was assigned a ten-minute block of time to report to the CAI teletypes and perform their daily lessons. These students came from any one of thirteen different classrooms. Peter Burnett is a completely departmentalized junior high school of the 7-9 variety located in the San Jose Unified School District, San Jose, California. Because of the departmentalized nature of the school, the arrival and departure times were critical if a "backing-up" problem at the machines was to be avoided. All students, seventh, eighth, and ninth graders, were started on the fourth-grade concept blocks beginning with 401 (addition). By the end of the year, the students had either completed or had been involved in thirty-two different concept blocks ranging from blocks 401 to 615, (each concept block consisting of seven lessons including pretests and posttests).

In addition to the objective evaluations that were made, the teachers and staff made these general observations: The teachers reported that the students were well behaved in departing and returning to their classrooms. They also noted a significant degree of attitudinal and motivational gains in their performance in class, as well as computing at a faster rate than the non-CAI students. These observations were made at the latter part of the school year, after the program had been in operation for more than six months. Other members of the teaching staff not directly involved commented on how well they were able to accept the responsibility of going through the halls without disturbing their classrooms.

The two CAI teletypes were located in the main office, adjacent to the Vice Principal's office (also Coordinator of the CAI program). The office staff were able to observe on a daily basis the relative behavior and general attitude of the students as they reported to their machines. The enthusiasm, motivation, and positive attitude were paramount in the office staff's comments as it regarded the vast majority of the participating students. There were, of course, a few exceptions as would be naturally expected of junior high students. There were, however, very few students who were not eventually "turned on" by the program. The mere fact that these students reported on time, from all parts of the campus without disturbing anyone, is in itself a real accomplishment.

Although an accurate analysis was not made, the attendance habits of these students seemed to improve. There were several instances that come to mind where students would report to the CAI teletypes and <u>then</u> report to the nurse because of an <u>apparent</u> illness they felt might send them home for the rest of the day. There were fifteen students not officially in the CAI program who came in during their lunch hour or after school on their own time to work on the

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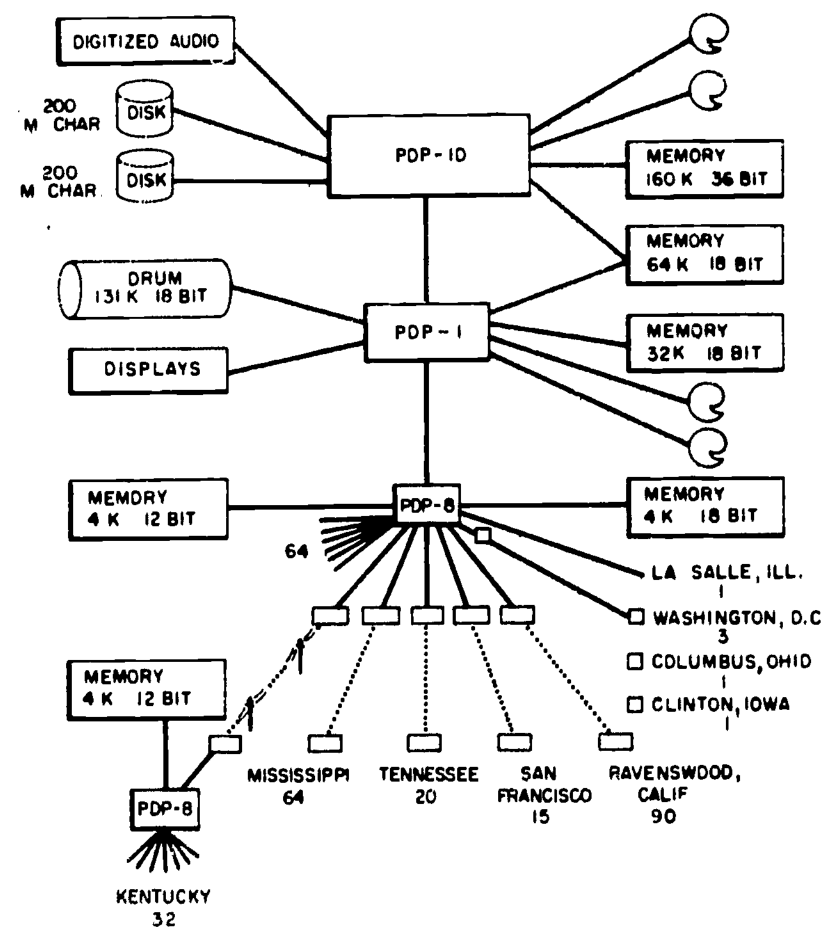

The figure at the left shows the present outreach of the Stanford CAI program. A total of nearly 250 teletype terminals are located in schools and homes across the country as shown. In the figure, the letter K stands for 1024. A core memory unit with 160K 36 bit words of memory means that it has 160 x 1024 words of 36 bits (zeros and ones) each. The snail-shaped symbols are tape drives. The displays are the cathode-ray tube displays (12) in the laboratory at Stanford. The digitized audio unit is presently set up to provide audio instructions to 40 users simultaneously. Its planned capacity is 72 users. As our switchover to the PDP-10 continues, the PDP-1 will be phased out. Perhaps it will be replaced by a larger computer in the future.

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teletypes. It was not possible to accommodate all interested students, for we even had a waiting list that never ended.

The statistical data obtained for the year based upon the Stanford Achievement Test (S.A.T.) was as follows:

	CAI S.A.T. (G.E.)			NON-CAI S.A.T. (G.E.)		
GRADE	PRE	POST	GAIN	PRE	POST	GAIN
7	4.20	5.11	+ .91	4.37	5.04	+ .67
8	4.21	5.98	+1.77	5.08	6.66	+1.58
9	4.00	6.15	+2.15	4.29	5.65	+1.36
AVE.	4.14	5.75	+1.61	4.58	5.78	+1.20

	CAI (AVE. FOR YEAR) DAILY LESSONS (%) CONC. BLKS 401-615	NET GAIN CAI over NON-CAI
7	75%	+.24
8	72%	+.19
9	77%	+.79
AVE.	75%	+.35

The above figures reflect scores in the same classrooms with the same educational environment. The only difference in the CAI students from the NON-CAI students was the ten-minute daily involvement in the CAI program.

The CAI students also showed a significant degree of improvement in their math grades. The majority of the students either received higher grades or maintained their past performance. In some cases, students were moved to a higher ability group and performed either as well or better than they had in a lower group.

We at Peter Burnett Junior High School are not only proud of our CAI students, but equally proud of having a program such as the CAI that contributes in its own inanimate way in motivating students who would normally not be reached.

Jim Moriel.

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TABLE 1

Total Number of Tests and Lessons
Given Students in Each Area

	California	Kentucky	Logic	Mississippi	Ravenswood	Washington, D.C.	
October							
9	136	46	32	18	1		
10	148	123	32	--	35		
14	96	--	26	--	3		
15	207	--	38	--	5		
16	191	--	18	47	11		
17	240	--	18	132	41		
18	223	--	31	285	40		
21	121	27	--	378	41		
22	238	52	21	470	34		
23	179	87	3	427	41		
24	224	57	26	721	59		
25	275	98	29	838	32		
28	291	31	22	652	40		
	2569	521	296	3968	383		7737
29	371	65	29	--	49		
30	407	51	39	831	33		
31	282	94	30	1460	32		
November							
1	309	56	29	1360	32		
4	416	5	37	1823	25		
5	389	9	35	2046	34		
6	420	8	26	1645	35		
7	364	205	36	2012	33		
8	423	188	18	1883	57		
11	69	36	9	1975	--		
12	451	--	34	2055	77		
13	534	4	7	1681	82		
14	334	78	5	2128	109	128	
15	307	14	18	2027	90	100	
18	327	288	4	1980	99	130	
19	267	314	17	1672	107	139	
20	386	245	5	1990	120	113	
21	329	278	24	1471	111	122	
22	249	309	10	1895	94	100	
25	352	293	4	1903	104	102	
26	274	345	--	1624	102	80	
27	354	241	8	1677	112	96	
December							
2	404	--	--	1044	134	55	
3	272	--	--	616	115	34	
4	28	16	--	375	7	8	
5	285	177	--	1659	156	115	
6	189	145	16	1073	34	33	
9	393	275	--	1742	90	83	
10	309	334	--	1746	85	96	
11	335	626	--	1208	77	75	
12	296	160	3	1614	105	95	
13	208	144	--	1704	192	18	
16			S Y S T E M	D O W N			
17							
18	211	222	--	1462	211	98	
19	260	241	--	1502	133	48	
20	199	137	--	548	--	54	
	13,572	6124	731	57,399	3259	1922	
							83,007

MAILING LIST: The response to our request for names and addresses for our mailing list has been very good. If you wish to have the newsletter mailed directly to you, send your name and address (please include your zip code) to: Max Jerman, Title III Coordinator, The Stanford CAI Program, Cedar Hall A-3, Stanford University, Stanford, California 94305.